MEMORANDUM

To: Vermont Agency of Transportation
From: CDM Smith
Date: September 28, 2021
Subject: Road Usage Charge Fee Structure

1. Introduction

This memorandum explains fee structure options and the policy options that impact fee structure design for flat fee/MBUF/per kWh fees for the state. The analysis in this memorandum reflects research and operational experience from US states and relevant foreign jurisdictions, with experience in piloting and operating systems, particularly Oregon, Utah and New Zealand.

The memorandum begins by providing background on important issues behind development of a fee structure, followed by a proposed set of criteria to guide development of fee structures for all three types of fees. A review and update of the previous flat fee estimate prepared by Vtrans in 2013 follows, with proposed rate options for a flat fee. Estimates for MBUF and per kWh are included, followed by an equity assessment considering impacts on rural and lower income households. The memo concludes with options for how to keep any such fees current over the longer term.

This paper includes recommendations from the consultant, CDM Smith, for consideration and discussion by the Vermont Agency of Transportation and the Road Usage Charge Advisory Committee and does not necessarily reflect the Agency's position or approved policies.

Detailed contents of this memorandum

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2. Background

Development of a fee structure for different road usage charging policy options is critical as it is both defined by and informs the design decisions for the system. Any fee structure needs to reflect the ability of the system to distinguish between different types of vehicles, interest in charging differently according to road use factors (such as location, even if it is distance traveled on public roads compared with private land, or distance within Vermont only) and the ability to be readily understood by those who will pay.

Introducing fees on owning, fueling or using a vehicle has a range of impacts on those who pay. This can include direct transportation impacts, such as affecting behavior (choices of which vehicles to own, distances to drive, where to charge a vehicle, which mode of transportation to use), economic impacts (impacts on business costs, availability of labor due to the cost of commuting) and wider social impacts (ability to pay and tradeoffs between paying for mobility and paying for housing, food and other essentials).

A fee structure should ensure generation of sufficient revenue for the purpose for which the fee is introduced, but it should also consider impacts on those who pay and avoid distorting the choices of those affected (for example, encouraging undesirable behavior). It should be considered dynamic, adaptable to changes in policy and external conditions. As the fleet changes and road usage patterns change, the structure should have the ability to respond, and should be supported by tools that consider demands to raise revenue and how different consumer choices affect revenue forecasts.

Fee structures directly inform revenue modeling and cost modeling, as well as communication to stakeholders about how much road users might pay, on what basis and why.

3. Criteria to establish fee structure

Synopsis

This section proposes the following seven criteria for setting rates for the flat fee, mileage-based user fee and the per-kWh fee:

1. Revenue generating potential;
2. Financial sustainability;
3. Flexibililty;
4. Equity and revenue neutrality;
5. Avoidance of negative impacts on electric vehicle adoption;
6. Economic efficiency;
7. Operational feasibility.

This range of criteria balances out the priority of raising revenue with the sustainability of introducing potential new sources of revenue and the impacts of those sources on vehicle ownership, usage and the subject communities.

Decisions

1. Should Vermont's flat fee seek to raise similar amounts of revenue per vehicle, reflecting the average MPG of light-duty vehicles in Vermont, multiplied by average miles traveled?
2. Should Vermont's mileage-based user fee seek to raise an equivalent per-mile of an average light-duty vehicle in Vermont pays in gas tax, reflecting average real MPG of such vehicles?
3. Should Vermont's <u>per-kWh fee for public charging stations</u> seek to raise *a proportion* of the value of gas tax raised per average gasoline powered light-duty vehicle in Vermont in one year, based on data collected as to the proportion of AEV and PHEV energy supplied through such facilities?

Introduction

Putting a price on a previously unpriced activity not only generates revenue but affects behavior. A flat fee on a certain type of vehicle is effectively a tax on owning that vehicle in the state, not using it. A road usage charge based on distance traveled (MBUF) is taxing road usage not vehicle ownership or fuel consumption. A per-kWh fee taxes consumption of electricity. The context of developing a fee structure must consider how it interacts with existing taxes on road usage, particularly the gas tax. The fee amount applied to electric and hybrid vehicles must be compared to the amount applied to gasoline powered equivalent vehicles, and variances from that justified on policy grounds.

Best practice elsewhere

Only three jurisdictions have currently operational programmes raising revenue from light duty vehicles based on a road usage charge: Oregon, Utah and New Zealand.

Oregon

Oregon's mileage-based fee structure is simple with a single rate for all eligible vehicles under the ORe*GO* program, directly comparable to the average gas tax paid per mile by conventionally fueled vehicles in the state. Oregon charges $0.018 per mile, which is intended to reflect the average of the remainder of the vehicle fleet. This simple calculation is equitable, by not discounting what alternatively fueled vehicles pay, and reflects a principle of user pays based on use of the road.

Longer term Oregon will revise this as state law ties the MBUF rate to increases in the gas tax rate. Ultimately, Oregon will require another metric on which to base the ORe*GO* rate, based on its regular Cost Responsibility Studies it uses to set its weight-mileage tax rates.[1]

Oregon has flat registration fees based on vehicles' fuel efficiency ratings-- the combined miles-per-gallon (MPG) rating as determined by its DMV's vehicle identification number (VIN) decoding software. Oregon charges registration fees at two or four yearly intervals, with the highest rate for AEVs, a rate around half that for high fuel efficiency (40+ MPG) vehicles and progressively lower fees for less efficient vehicles. This structure charges the highest fees on vehicles that don't pay gas tax, and the lowest fees on those that pay the most gas tax. For owners of AEVs and PHEVs (which would qualify as high fuel efficiency) that choose to pay MBUF, their flat fees are reduced considerably (from $306 to $86 for AEVs, or from $152 to $86 for PHEVs for two years). This fee structure incentivizes such vehicle owners to choose MBUF, but also seeks to recover the gas tax that more fuel efficient vehicles or AEVs do not pay through the flat fee. Although ORe*GO* charges the same rate for AEVs as with PHEVs, it credits gas tax paid by PHEVs to that vehicle's MBUF account, so that PHEVs do not pay twice if paying MBUF.

[1] See latest version of this study at https://www.oregon.gov/das/OEA/Documents/HCAS_19-21.pdf

Utah

Utah's MBUF fee structure is equally simple, with a rate of $0.015 per mile for electric and PHEVs. Utah adopts a similar approach to setting flat fees. Instead of paying MBUF, flat fees of $120 apply fo AEVs and $52 for PHEVs in addition to annual registration fees. This also reflects that plug-in hybrids pay gas tax, regardless. In Utah, it is a straight choice between paying a flat fee or paying MBUF, although PHEVs paying MBUF do not get credit for gas tax paid.

New Zealand

New Zealand's RUC system encompasses light-duty vehicles that are not powered by gasoline or natural gas, but also all heavy vehicles, so has a complex rate structure for heavy vehicles. Light vehicles pay a single per mile rate, with no flat fee alternative. However, that single rate is informed by the Cost Allocation Model used to estimate what rate structure is required to raise revenue to pay for future land transportation expenditures. It generates a RUC figure for all light-duty vehicles to be charged, and converts this to a similar figure for gas tax, based on average fuel efficiency per kilometer traveled. The rate is comparable to what gasoline powered vehicles pay, on average, and is informed by economic analysis as to how much each *type* of vehicle should pay for different types of spending. For example, the model allocates road maintenance based on a mix of fixed costs per vehicle and variable costs dependent on vehicle weight, whereas expansion of road capacity reflects vehicle size as a function of road space occupancy. Electric vehicles are current exempt in New Zealand, but the Ministry of Transport expects AEVs to become subject to the RUC system when they reach a set percentage of the vehicle fleet. All types of hybrid vehicles only pay the gas tax at present, resulting in them paying less on average per kilometer than other light-duty vehicles.

In both Oregon and Utah, the per mile rates for AEVs compared to plug-in hybrid electric vehicles are identical, although in Oregon, any vehicle owners with vehicles in the OReGO program receive credits for gas tax paid, which is credited to the vehicle's OReGO account, so that PHEVs are not double taxed.

Table 1 MBUF rates in other jurisdictions

Rate per mile (US$)	**Oregon**	**Utah**	**New Zealand**
All-electric vehicles	0.018	0.015	0.076[2]
Plug-in hybrid vehicles	0.018	0.015	n.a. (gas tax only)

[2] AEVs in New Zealand are temporarily exempt to encourage growth in ownership, this is the rate that applies to other light duty vehicles subject to RUC.

Table 2 Flat fee rates in other jurisdictions

Flat fee rate per year	**Oregon** (assuming not paying MBUF)	**Utah**
All-electric vehicles	$158	$120
Plug-in hybrid vehicles	$76	$52

Conclusions

Oregon, Utah and New Zealand all take approaches that meet a number of policy objectives. All deliver revenue sustainability, and have flexibility to adapt to policy conditions. In all cases, it would be relatively easy to expand the scope of their MBUF programs to include a wider range of vehicle types. All program designs deliver equity and economic efficiency in the rates set, relative to fuel taxes, as they ensure those paying MBUF pay approximately what other types of vehicles will pay. All have adopted policies to encourage purchases of AEVs and PHEVs related to their rates policy, in different ways. For Oregon and Utah, the choice of paying a flat fee or a per mile fee effectively caps what AEVs pay (and partially caps what PHEVs pay), which is not an option for gasoline powered vehicles. In New Zealand, AEVs have a temporary exemption, but PHEVs are outside the RUC program at present (and only pay fuel tax for the gasoline used).

Proposed objectives

Seven criteria are proposed to underpin rate setting for flat fee, MBUF and per-kWh rates for Vermont as follows. These are described in greater detail in following sub-sections:

- **Revenue generating potential**: The ability of the rates to raise sufficient *net* revenues to be worthwhile introducing.
- **Financial sustainability**: The potential for the rate schedules to be responsive to changes in vehicle ownership and usage
- **Flexibility**: The rate schedule should be sufficiently flexible to be adapted to changes in policy to meet changing conditions over time.
- **Equity and revenue neutrality**: The rates should be broadly commensurate to what other types of vehicles are charged to use the roads, so that those paying any of the three types of fees are not burdened, on average, greater than other road users. This may also take into account avoiding imposition of a sudden increase in fees for members of vulnerable communities.
- **Avoid negative impacts on AEV and PHEV adoption**: The objective of raising revenue should be balanced by wider policy interest in maintaining growth in adoption of AEV and PHEVs both in ownership and usage.
- **Economic efficiency**: The rates structures should not distort economic activity or encourage transportation use decisions that are less efficient than apply to other road users. The rates structure should seek to raise revenue from road users reflecting their usage of the network, and reflecting their contribution to what is spent on the network.
- **Operational feasibility**: Rates structures should be able to be readily applied in practice, precluding opportunities for evasion or fraud.

This range of criteria is intended to balance out the obvious priority given to raising revenue, over the sustainability of introducing potential new sources of revenue and the impacts of those sources on vehicle ownership, usage and ultimately the communities that may be subject to the charge.

Characteristics of different fee types

A flat fee, MBUF and per-kWh fee all have inherently different characteristics that define, but also limit, development of a rate structure for them.

The inherent characteristic of a flat fee is that it is imposed on *ownership* of a vehicle in the state. It doesn't vary according to usage and cannot be imposed on vehicles from out of state. A flat fee inherently charges some vehicle owners more than they would pay if the same fee were converted into a per-mile or per-kWh fee, and some less. The flat fee advantages those traveling the most miles, as the cost is spread over much more road use, than for those traveling the fewest miles. As a flat fee, its revenue is based on the *number of registered vehicles* which broadly reflects scale of ownership of those vehicles. When ownership rises revenue increases, but at stable ownership levels it does not vary (similarly at times of economic downturn it does not respond quickly to such changes, as fewer miles traveled or less energy consumed does not affect revenue, although sustained downturns may see small reductions in the numbers of registered vehicles).

MBUF has the characteristic of a *usage*-based fee. It varies entirely by distance traveled. As a usage-based fee, MBUF rises and lowers in revenue based on the amount of road travel, independent of vehicle ownership, but more susceptible to changes in economic activity. Compared to the gas tax, which is also a proxy fee for usage, MBUF revenue is limited on the consumption of the relevant unit, in this case, miles traveled. Unlike a flat fee or per-kWh fee, a MBUF can vary by increments such as location (to avoid distance traveled off of public roads or out of state), by applying relevant technology to measure that factor.

A per-kWh fee on public charging stations has the characteristics of a proxy-based usage fee. It varies by electricity used to charge a vehicle and can be imposed on vehicles from out of state, but because public charging stations are not the only source of electricity (or for PHEVs not the only source of energy), a per-kWh fee cannot be applied universally to all road usage. AEVs and PHEVs can be charged in private-residences, and PHEVs can also be refueled with gasoline, so unlike the flat fee and MBUF, a per-kWh fee on public charging stations can be readily *avoided* by sourcing energy from these alternatives. As a usage-based fee, a per-kWh fee will increase and decrease in revenue based on the amount of road travel, particularly for vehicles traveling far from the home of the owner, or from state borders (beyond which there are public charging stations without such a fee). However, it is likely to be more sensitive to price levels changing behavior than either an MBUF or a flat fee. That is because the taxed behavior has more readily available alternatives. To avoid a flat fee would require not owning the vehicle in the state, and to avoid the MBUF would require not driving within the state (evasion of both would be more onerous, but still possible). To avoid a per-kWh fee for AEVs means avoiding public charging stations in Vermont, or for PHEVs to use gasoline instead.

These characteristics are affected if more than one of them might be implemented in parallel for the same types of vehicles and if it were implemented as two compulsory fees or one fee being optional. For example, enabling a choice between either a flat fee or MBUF for AEVs (as is done in Utah) effectively places a cap on the amount vehicles that can be charged under MBUF, because the flat fee at a certain point becomes cheaper than paying for every additional mile.

One issue is that choices need to be made as to the proportion of revenue to be raised by different fees, and the demand elasticity impacts of this on various behaviors. For example, if it were decided to raise 66% of revenue from a flat fee, but the remainder from MBUF, then MBUF would need to be much lower than if the flat fee were to raise only 25% of revenue. I

Revenue generating potential

The primary focus of any revenue collection system must be how much revenue is it intended to raise. Although ultimately a political decision, it should be informed by reflecting upon two key factors:

- Demand for revenue (how much money does the state want to raise to pay for transportation).
- Relativities with other fees (how much money does the state raise from gasoline powered vehicles, per annum, per mile).

The revenue potential should reflect revenue net of any costs of collection, recognizing that some fee types may have higher costs of collection than others (for example, MBUF has higher collection costs than a flat fee in addition to what is already charged for vehicle registration). Ultimately revenue potential will be reflected in:

- The basis of the fee (what is being charged? Is it ownership or usage and can the usage be adjusted to minimize payment of the fee, at relatively low cost to the responsible person?)
- The relativity of the fee to how other vehicles are charged (does the fee encourage a shift away from the charged vehicle type to others?)
- Scale of the fee (as levels increase they can discourage behavior or encourage fraudulent activity to minimize liability).

The initial basis of revenue generating potential can be based either on the revenue generating potential of the gas tax applied equivalently to AEVs and PHEVs or on a separately identified revenue target (representing how much revenue per vehicle or per mile is sought). Longer term the latter approach is likely to be more sustainable, as it should reflect how much money the state wants to spend on transportation from fees on motor vehicles, rather than echoing the existing fees on one class of vehicle. The latter is how Oregon and New Zealand inform fee setting for their MBUF programs.

Financial sustainability

The base of the three fees determines their sustainability. Key issues around sustainability of all three fees are:

- Resilience of the fee to external events (for example, economic recession or growth, technological change);
- Ability of road users to minimize financial liability by easily changing behavior;
- Likely longer term impacts of the fee on behavior to reduce liability; and
- Responsiveness of the fee structure to changes in policy.

A flat fee is likely to be most responsive to external events, as revenue is much more moderately affected by economic growth or recession than usage based fees (as the effects of economic change are most immediately seen in the *use* of existing vehicles than any increase or reduction in the *number* of such vehicles, although sustained recession may see registration of older vehicles lapse). However, given the fee may be applied to AEVs and PHEVs, it may be reasonably expected that growth in such vehicle numbers is likely to be sustained for many years. As that growth stabilizes, so will revenues. An MBUF would also grow as vehicle numbers increase, as the number of total miles driven by AEVs and PHEVs increases along with revenue. A per-kWh fee may grow as use of public charging stations (and numbers of such charging stations) grow, but unlike an MBUF, revenue from a per-kWh fee is limited by the capacity of public charging stations, and frequency of use. External constraints on the provision of such facilities may hinder growth in such fees as the AEV and PHEV fleet grows.

The only way to avoid a flat fee is not to own an AEV or PHEV in Vermont (or to acquire one and evade registration), which is simply a factor of the incidence of the fee. An MBUF can only be avoided by driving fewer miles, but a per-kWh fee on public charging stations can be avoided by recharging at other locations (or for PHEVs fueling at a gas station). This makes per-kWh fees potentially more subject to elastic demand, depending on the level of fee charged and the profile of users of public charging stations. Further research may identify how different types of AEV and PHEV users identify such facilities (and charging stations that may be free, or complementary with certain facilities) and their sensitivities around price, location and range. The availability of mobile phone apps to search for locations may influence how elastic demand is by users (e.g. occasional visitors may be different from regular visitors).

Flexibility

A rate structure should be flexible enough to be able to be adapted to a wider range of vehicles (such as conventional hybrids or other highly fuel-efficient vehicles) and to respond to changes in policy and external conditions. It should be able to be responsive to changes in the vehicle fleet, in vehicle usage and demands for revenue.

Equity and revenue neutrality

Equity

In the context of fees for road use, the reference point for equity is the pre-existing gas tax which applies to nearly all light-duty vehicles in Vermont. It is assumed for the purposes of this paper that, given its universal application, it is seen as a fair and equitable means of charging gasoline powered light duty vehicles for road use. Equity is seen in the principle of user pays, so that those who benefit the most from spending on the road network, pay the most, based on the proportion of their usage. Traditionally this is seen in the consumption of fuel reflected in the gas tax, but as AEVs do not pay this (and PHEVs pay only a fraction of it), the flat fee, MBUF and per-kWh concepts should all be developed with the user pays principle in mind. Alongside equity, revenue neutrality existed in the sense of how much vehicles were taxed to use the roads through the gas tax, but the gas tax is not viable for vehicles that use no or significantly less gasoline than conventional gasoline powered vehicles. To address this, a structure of flat fees, MBUF or per-kWh fees should seek to apply some neutrality to how much light-duty vehicles owners have to pay to use the roads.

The level of equity accepted by the existence of the gas tax has been challenged by AEVs, PHEVs, conventional hybrid vehicles and more fuel-efficient gasoline powered vehicles. This has more clearly revealed the gas tax for the proxy tax that it is, based on fuel consumption, not distance traveled. The actual amount paid per mile reflected roughly the amount of road use of a driver, the driver's behavior (such as load carried and speed of acceleration, braking) and the choice of vehicle (larger engines meant more fuel consumption so more gas tax paid).
Many of these factors are choices, generally accepted as being reasonable. A small vehicle carrying one person doing short journeys is charged less gas tax than a large vehicle carrying many people on a long trip. This has been accepted as equitable although there is little relationship between what is paid to the costs attributable to using the roads.

With AEVs and PHEVs paying no or significant less gas tax than other vehicles, and being new vehicles, this means that a demographic able to afford new (and more expensive) vehicles can avoid the gas tax entirely or significantly.

Revenue neutrality

Revenue neutrality under the gas tax is a function of the average vehicle with the average actual fuel consumption per mile. Flat fees and per mile fees do *not* vary based on these factors, although a per-kWh hour fee does because like the gas tax, it is a type of (albeit potentially less accurate) proxy tax based on energy consumption (although it may be even less of a proxy given the variation of energy consumption of AEVs based on external conditions, and moreso with PHEVs which offer more energy use options for drivers).

Revenue neutrality is more than seeking to ensure that two vehicles, powered differently, driving identical trips, are charged the same fee amounts to use Vermont roads. It must also reflect the costs of collection, which will be higher for a per mile and a per-kWh rate, than for the gas tax and for a flat fee collected at the same time as vehicle registration fees. Rates for those fees should include a factor for those costs, so that the *net* revenue neutrality is identical. True revenue neutrality is not possible, as both a per-mile and a per-kWh fee would need to include a factor for the additional costs of collection. It is likely to be more equitable that this cost is born by the road user (reflecting the choice of vehicle type that requires setting of the specific fee), than be cross-subsidised by owners of other types of vehicles.

The inherent characteristics of each type of fee affect how far the principle can be applied, compared to the gas tax. A flat fee can only be applied as some function of an average proportion of road use. Those who drive less than average subsidise those who drive more than average. From an equity perspective, this may not matter very much for owners of brand new or relatively new AEVs and PHEVs, if those owners tend to have higher incomes, but longer term this may be an issue as more such vehicles become available in the user vehicle market, and are acquired by people with more limited incomes.

An MBUF is more akin to the gas tax, in that it charges based on usage, so can be set at a rate equivalent to the per-mile average gas tax paid either of a new gasoline powered light-duty vehicle or the average such vehicle in the state. Low usage reflects low fees and vice versa for high levels of usage. The relationship to the gas tax may be a reasonable starting point for setting an MBUF rate, but as the vehicle fleet changes, this may *reduce* revenue from the gas tax per mile (as more fuel efficient vehicles are acquired which are not liable for an MBUF, although they could be transitioned to it). Unless the gas tax is regularly increased proportionate to improvements in fuel efficiency of those paying the gas tax, any relationship between the rate of light-duty MBUF and gas tax will be inadequate to ensure revenue keeps pace with demand. There are merits in considering taking a more strategic approach to setting such rates, based on a cost-responsibility approach considering future needed revenues based on a forward looking base of costs for transportation.

A per-kWh fee for public charging stations cannot reasonably be applied with broad revenue neutrality because it is already defined to be applied to a proportion of energy used by AEVs and PHEVs. It is difficult to extract data as to what proportion of travel was undertaken using energy from those charging stations compared to other sources. Such fees could only reflect a *proportion* of such travel, as if they sought to fully recover equivalent revenue as the gas tax, this might encourage avoidance of public charging stations compared to private charging points (or for PHEVs, simply buying gasoline to cover not driving near home).

A per kWh fee may also be seen as penalizing those who have AEVs and PHEVs and must use such charging points, because their trips go beyond the range of such vehicles that enables them to reasonably use alternatives.

Avoid negative impacts on AEV and PHEV adoption

By allowing PHEVs to use the roads according to the gas tax they pay and allowing AEVs to avoid a fee altogether, this further incentivizes the acquisition of both. The impact of this is not readily apparent, as for both vehicle types the more obvious savings come from not paying for gasoline. The gas tax isn't paid separately from the gas itself, so the tax benefit is less noticeable. However, it is unsustainable, as well as inequitable and inefficient for AEVs and PHEVs to use the roads either for free or or at a high discount, as ultimately it would result in infrastructure deteriorating or a growing proportion of the costs of maintaining the roads borne by those without such vehicles.

The impact of either a flat-fee, MBUF or per-kWh fee on public charging stations on vehicle fleet purchases will primarily be a factor of the fee level. A flat fee inherently becomes a tax on owning a specific type of vehicle, although given the cost of the cheapest new AEVs and PHEVs, the level likely to have an effect on purchases is likely to be somewhere above $500 or more per annum. It is effectively an inverse relationship to the provision of incentives to purchase such vehicles in some jurisdictions. In effect, any fee on AEVs and PHEVs needs to sufficiently offset perceptions of savings in fuel and maintenance, but also push a buyer over their price point for buying such a vehicle relative to a conventionally powered car.

An MBUF rate is more akin to the gas tax, so a rate of a few cents per mile is much less likely to impact purchase decisions, with those who drive high mileage already paying higher gas taxes if they did not own an AEV or PHEV. A per-kWh fee for public charging stations is also less likely to impact purchase decisions, unless it were at a rate that would deter charging at such locations, which would reduce the perceived utility of AEVs and PHEVs (although PHEVs still have the alternative of gas stations).

Given the purchase price of AEVs starts at around $27,400, a flat fee that charges less than 1% of this per annum is highly unlikely to dissuade purchasers of such vehicles. AEVs and PHEVs already cost a premium, and it is noted that the main reason dissuading AEV and PHEV purchases is upfront cost.[3] It is noted that this generates higher sales tax revenue than gasoline powered vehicles as a result, although over time AEVs and PHEVs have progressively become more competitive with gasoline powered cars in terms of price. This relatively high price is why incentives on initial purchases are the most important way to encourage a shift in the fleet. Likewise, given the savings of gasoline of $0.136 per mile[4] compared to an average car, not charging a mileage fee akin to Oregon or Utah of <$0.02 per mile is also highly unlikely to be influential in whether or not to buy an AEV compared to a gasoline powered car. Drive Electric Vermont estimates that AEVs save on average $744 per annum in fuel costs, it is likely that this would need to be offset considerably to dissuade purchases of AEVs.[5]

[3] Source: PUC Case No. 18-2660-INV, Drive Electric Vermont comments at 3; Department of Public Service Final Comments dated 5/13/19 at 7.
[4] Based on average MPG and current gasoline prices as of September 2021 https://vtrans.vermont.gov/contract-admin/resources/construction-contracting/fuel-price-adjustment
[5] Source: https://www.driveelectricvt.com/about-evs/cost-of-ownership

Economic efficiency

A basic principle of economic efficiency is that services should be consumed according to consumer preferences and willingness to pay. It is economically efficient to charge a fee to use the roads that reflects the costs of providing the road and a fair reflection of the consumption of the road by the road user. Fee rates should seek to reflect these costs. Rates should also encourage efficient use of the roads, and not their overuse (as overuse may generate congestion). Although charge rates in this context are not designed to alter behavior, having charge rates that reflect a fair proportion of the costs of maintaining the road networkwill encourage more efficient use of the network than if rates are either too low (encouraging excess use) or too high (not enabling road users to utilize the roads sufficiently).

Operational feasibility

There is little point having a rate structure that cannot be implemented or operated using available systems or data, so it is important that a rate structure have elements that can be implemented and not be infeasible practically. The key components of operational feasibility are:

- <u>Fee elements that do not distinguish between vehicle or vehicle occupant characteristics of behavior that are difficult to reliably identify, measure and report</u>. For example, a per-kWh fee structure that sought to also reflect gas tax paid by a PHEV may be too technically complex to implement. A flat fee structure ought to reflect characteristics that are held or able to be readily held by a motor vehicle register database. An MBUF structure should also reflect such characteristics, or any road use elements readily detectable by the appropriate charging technology. A per-kWh fee on public charging stations could vary by location, but is unlikely to be able to vary by type of vehicle being charged.

- <u>Scalability</u> so that the structure can be applied more widely if policy changes to include additional vehicle types (such as conventional hybrid and gasoline powered vehicles, or heavy vehicles).

- Flexibility, so that the rate structure can be adapted over time, without needing to be changed for the vehicles subject to it initially.

- Easy to understand metric, so those who have to pay it, and may wish to estimate how much it will cost them to pay.

- Clear identification of applicable vehicles, so vehicle owners can clearly identify what types of vehicles will pay how much depending on the relevant metric (ownership, distance traveled or kWh charged).

- Discouraging evasion. The level and design of fee should not be such that it encourages or enables behavior to evade it. For flat-fees that is a matter of evading registration in

Vermont, albeit that this risks undermining any insurance (especially for vehicles of relatively high market value). For MBUF, depending on the technological solution available, it may encourage behavior to falsify or minimize mileage measurement. Per-kWh fees at public charging stations would simply deter use of such facilities (and perhaps the emergence of informal paid for charging stations to avoid the fee).

Recommended approach

It is recommended that Vermont balance the criteria listed above across three main principles:

- Revenue potential (based initially on relativity to gasoline-powered vehicles, but longer term based on meeting revenue targets).
- Equity through net revenue neutrality (ensuring on average, AEV and PHEV owners do not pay more, than the average gasoline-powered light-duty vehicle owners pay to drive in Vermont with the gas tax).
- Minimizing distortions in behavior that might risk revenue sustainability or AEV/PHEV adoption (ensuring a rate structure does not generate rates that discourage ownership or use of AEVs, or changes in behavior that are inefficient.

From this criteria this should inform the setting of the three types of fees as follows:

A flat fee for AEVs should seek to raise similar amounts of revenue per vehicle, as the gas tax raises per average gasoline powered light-duty vehicle in Vermont in one year. This level should reflect the average MPG of a light-duty vehicle in Vermont, multiplied by the average miles traveled. A flat fee for PHEVs should seek to raise the *difference in revenue* from the average gas tax paid by a PHEV in Vermont and the gas tax raised per average gasoline powered light-duty vehicle in Vermont in one year.

An MBUF should seek to raise an equivalent per mile of the average light-duty vehicle in Vermont pays in gas tax, reflecting average real MPG of such vehicles. This should apply in full to AEVs. PHEVs should either be charged the same rate as AEVs (and receive a credit in gas tax payments) or should be charged a lower rate that corresponds to the difference between average gas tax paid per mile, and that paid by an average PHEV (if such data is readily available for Vermont).

A per-kWh fee for public charging stations should seek to raise *a proportion* of the value of gas tax raised per average gasoline powered light-duty vehicle in Vermont in one year, based on data collected as to the proportion of AEV and PHEV energy supplied through such facilities. This indicates that a per-kWh fee will not raise equivalent revenue to the gas tax for gasoline-powered light-duty vehicles, nor be equitable/revenue neutral with such vehicles. A rate that would be similar to that for a flat fee or MBUF would be likely to be high enough to deter use of such facilities, which would favor owners of AEVs and PHEVs with home charging options.

4. Updated flat fee estimates

Synopsis

Revising estimates from 2013 Agency of Transportation study, calculating the light duty vehicle fuel economy at 22.7 MPG and an average vehicle miles traveled of 10,497 per annum, the flat fee for all-electric vehicles should be about $139 per year. Given that plug-in hybrid electric vehicles pay about 60% of what the average gasoline powered vehicles pay in gas taxes, the flat rate for PHEV's should be about $55 per year.

Decision

Should Vermont set the flat fee amount at $139 per year for all-electric vehicles and $55 per year for plug-in hybrid electric vehicles?

Previous estimates

VTrans undertook a study in 2013 to estimate the rate that would be appropriate for a flat rate fee for AEVs and PHEVs, this followed a study in 2012 that estimated an annual registration fee for AEVs based on the "mean amount of gas tax paid annually by the average Vermont driver using average rates of annual vehicle miles traveled, fuel economy, gas prices and gas taxes in the state". That figure at the time was $146.

The 2013 study revised this by considering the fuel economy of not the average vehicle in the state, but average *new* light duty vehicles, which would be more comparable to purchasing a new vehicle. That fuel economy was considered to be 34.2 MPG but "de-rated" by 20% so that the CAFÉ standard reflected real-world driving conditions.

The average vehicle miles traveled in Vermont that year was calculated to be around 12,400, with the gas tax rate of $0.3126 per gallon. The average miles traveled was adjusted by a factor to reflect an assumption of fewer miles driven by a AEV compared to a gasoline powered vehicle, primarily because of technical limitations and associated driver concern about range. This was assumed to be a 15% reduction in miles driven per annum.

The calculation was also applied to PHEV, with the assumption that although such vehicles may drive similar miles to a gasoline powered vehicle, PHEV's pay gasoline tax on the gasoline they consume, and so it was assumed that on average, PHEVs pay half the gasoline tax of other vehicles.

The end result was a proposed fee of $120 for AEVs and $71 for PHEVs.

Some of the statistics used in the study have some ambiguity:

- The fuel economy of the average new light duty vehicle was not indicated as being Vermont specific or US wide;
- The average vehicle miles traveled in Vermont was not indicated as applying to light vehicle only or all vehicles.

It is assumed that, given the absence of data, that the average new light duty vehicle fuel economy was a nationwide figure[6], and the average vehicle miles traveled is across all vehicles.

Revised estimate

Fuel economy

The latest figure for the average fuel economy of a new light duty vehicle in the United States is 25.7 MPG in 2020 according to the Office of Energy Efficiency and Renewable Energy.[7] This is *lower* than the 34.2 MPG that was included in the previous report (as being reported by automotive manufacturers), but this includes all light duty vehicles under 8,500lbs gross vehicle weight.[8] As 25.7 MPG is considered "real world" MPG, this does not need to be down-rated like the previous estimate. Two other estimates have been found, but are likely to be inferior for the following reasons:

- 22.7 MPG is the reported EPA fuel economy for *all* vehicles registered in Vermont in 2019, not just newly registered that year, so will be lower than the newly registered.[9]

- 19.5 MPG is calculated based on dividing fuel sales with total VMT.[10] This may also reflect the fuel consumption of heavy-duty vehicles, which will be considerably higher per mile traveled than light-duty vehicles, so is likely to be an inappropriate figure for a light-duty rate.

An important policy consideration is whether to set the fee based on the *entire* fleet or just *new* vehicles. This is discussed in the following sub-section.

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[6] This source verifies the fuel economy figure albeit from a subsequent year http://needtoknow.nas.edu/energy/energy-efficiency/cafe-standards/
[7] https://www.energy.gov/eere/vehicles/articles/fotw-1177-march-15-2021-preliminary-data-show-average-fuel-economy-new-light
[8] https://www.epa.gov/automotive-trends/explore-automotive-trends-data#DetailedData
[9] Source: Table 3-4 https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf
[10] Source: Table 3-5 https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf

Vehicle miles traveled

The average vehicle miles traveled in Vermont in 2017 is 11,888, which is higher than the national average of 9,825, this may in part reflect the high proportion of rural VMT (71% of the total) which itself is higher than the national average.[11] However, this statistic includes both heavy and light duty vehicles, so it is appropriate to consider whether the average vehicle miles traveled fairly reflects distances likely to be traveled by light AEVs and PHEVs

The vehicle fleet in Vermont is comprised of around 620,000 vehicles, but of those around 88% are light-duty vehicles, nearly 6.5% are heavy trucks, 5% are motorcycles with buses and other vehicles the remainder. According to FHWA statistics the average VMT traveled by light duty vehicles in the United States is considerably less than for heavy trucks.[12] On a national average for every mile traveled by a light duty vehicle (including pick-up trucks, vans and SUVs), a heavy truck travels 1.96 miles. Although recent statistics separating heavy and light-duty vehicle VMT in Vermont have not been sourced, if this assumption is applied to Vermont, it means that the heavy truck fleet travel, on average around 20,574 miles per annum compared to light-duty vehicles traveling around 10,497 miles per annum.[13]

This is likely to be a fairer reflection of average light-duty vehicle travel in Vermont per annum. The previous study assumed a factor of 15% to reduce the average miles traveled by AEV, due to the likelihood that AEVs have shorter range and may be used for shorter distance trips on average compared to gasoline powered vehicles. AEV performance has increased markedly since 2013, and this is likely to continue, due to battery technology and the increased availability of charging points. It appears reasonable to not discount the average mileage for light-duty vehicles. For PHEVs this assumption is unnecessary, as by design they do not face range limitations any greater than gasoline powered vehicles. One study suggests that PHEVs are driven, on average, more miles per annum than gasoline powered vehicles (by 1.3%), but this is insufficient evidence in itself to adjust the calculation on that basis.[14]

However, PHEVs do consume gasoline and are subject to gasoline tax, so a factor needs to be calculated to take that into account. There is insufficient data about the proportion of miles driven by PHEVs using electricity over gasoline, and the fuel efficiency of PHEV gasoline engines varies considerably. Reliable statistics on average PHEV MPG are difficult to source, in part because the EPA now publishes two sets of figures for PHEVs to reflect driving using electricity and then using gasoline. Data from 2016 indicates that PHEVs, on average, have a MPG of 37.9.[15] If compared to standard MPG, this means that, per mile, PHEVs consume around 68% of the gasoline of an average new light-duty vehicles. This indicates an assumption of 68% is

[11] Source: https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf
[12] Source: https://www.bts.gov/content/us-vehicle-miles
[13] Noting motorcycles nationally travel as little as 20% of the average VMT as light-duty vehicles, but buses travel on average 57% more .
[14] Source: https://theicct.org/sites/default/files/publications/PHEV-white%20paper-sept2020-0.pdf
[15] Source: https://afdc.energy.gov/vehicles/electric_emissions_sources.html

reasonable, noting that PHEV gasoline engine fuel efficiency varies considerably (from 18-54 MPG).[16] That means that the PHEV rate only needs to recover the remaining 32%, as it is already paying 68% of the gas tax of comparable new vehicles.

Gas tax

The state gas tax rate today is $0.30/gallon.

Calculation

Based on this calculation, with 25.7 MPG average for travelling 10,497 miles, the average new light vehicle in Vermont consumes just over 408 gallons per annum. This represents an annual state excise tax payment of around $123 for AEVs, with $39 for PHEVs. This compares to the previous flat fee calculations of $120 and $71 respectively for AEVs and PHEVs.

Variations on the flat fee estimate

There are two broad options to vary the estimated flat fee calculation:

- Base MPG on the average of *all* light-duty vehicles in Vermont, not just newly registered ones (this would assume a lower MPG, and a higher flat rate)
- Set a fee based on higher than the average VMT for a light-duty vehicle, so that half of those paying are not effectively getting a discount on travel compared to those paying the gas tax

MPG of all light-duty vehicles

If equity, revenue neutrality, and economic efficiency are considered higher priorities, then it would be appropriate to base the calculation on the average MPG of *all* light duty vehicles in Vermont, using the figure of 22.7 MPG. This would mean the flat fee better reflects what all light vehicle owners are paying to use the roads on average, rather than only those who purchase new ones. As AEVs and PHEVs are not "new" for more than one year, this would better reflect a fairer contribution towards the costs of the road network. However, this would also apply to the calculation of what PHEVs already pay in gas tax. Comparing 37.9 MPG to 22.7 MPG means that PHEVs pay around 60% what average gasoline powered light-duty vehicles pay, in gas tax.

Using the average MPG rate for all light duty vehicles alone would increase the flat fee for AEVs from $123 to around $139 and by having a wider gap in fuel efficiency for PHEVs compared to other vehicles, the flat fee rate would be around $55 compared to $39 calculated above. This would better reflect what other light-duty vehicles pay to use the roads in the state, on average, and may encourage PHEV owners to use electricity more frequently than gasoline.

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[16] Source: https://www.fueleconomy.gov/feg/PowerSearch.do?action=noform&path=1&year1=2020&year2=2021&vtype=Plug-in+Hybrid&pageno=1&rowLimit=50&sortBy=Comb&tabView=0

Higher mileage assumption

However, the average mileage per vehicle is questionable in equity terms. This may be higher for some vehicles and lower for others. Gasoline powered vehicles don't have a cap on how much they pay to use the roads, so those vehicles that accrue higher mileage would in effect be cross-subsidising the half of AEVs and PHEVs that do so. It might be assumed that buyers of new AEVs and PHEVs may drive more miles than those with older vehicles, and more miles than gasoline powered vehicles (because the cost per mile to drive and to maintain is lower). Although, one survey indicated that only 11% of buyers of AEVs put savings of gasoline as the primary reason for purchasing one, this does not mitigate the savings in driving that might incentivize driving more frequently and further distances, nor noting the appeal in getting greater discretionary use out of a relatively new vehicle.[17] Increasing the average mileage per vehicle by 25% would mean the flat fee would better reflect what other higher mileage vehicles would pay, although this may also incentivize AEVs and PHEVs to be driven more miles. This may also support the policy of introducing a MBUF as an alternative to the flat fee, to mitigate the effect of the higher fee on some road users. The effect of this change alone would be to generate an annual fee of $153 for AEVs and $49 for PHEVs. Combining the lower MPG rate for average vehicles and higher mileage would generate an annual fee of $173 for AEVs and $69 for PHEVs.

Table 3 Range of estimates of flat fee based on different assumptions

	MPG assumption	VMT assumption	AEV fee	PHEV fee
Original estimate (2013 Study)	27.36[18]	10,540[19]	$120	$71
Updated estimate	25.7	11,888	$139	$44
All vehicle MPG	22.7	11,888	$157	$50
VMT for light-duty only	22.7	10,497	$139	$44
Higher VMT	25.7	13,121	$153	$49
Higher VMT lower MPG	22.7	13,121	$173	$55

Effect on sales

The cheapest AEV at present is the Mini Electric Hardtop at $29,900 compared to $19,750 for an entry level gasoline model. A fee of $120 would be 0.4% of the purchase price. With the savings in gasoline of around $1,180 a year (based on current fuel prices and annual consumption of 408 gallons), although offset by electricity of around $624 a year in charging[20],

[17] Source: https://today.yougov.com/topics/consumer/articles-reports/2020/10/23/whats-stopping-americans-buying-electric-cars
[18] 34.2MPG derated by 20%.
[19] 12,400 derated by 15%.
[20] Based on calculations using https://afdc.energy.gov/calc/

the annual flat fee would need to significantly erode that saving to influence purchase decisions.

The cheapest PHEV at present is the Hyundai Ioniq at $26,700, which is already $3,300 more than the gasoline model.[21] A fee of $62 would be 0.2% of the purchase price. Given that the vehicle halves gasoline consumption, saving around $600 a year (based on current fuel prices and annual consumption of 408 gallons), and the vehicle is already at a premium (and might be assumed to return the premium in gasoline savings within six years). As with AEVs, the annual flat fee would need to be in the order of several hundreds of dollars to influence vehicle purchase choices.

The effect of this is that there should be caution in considering fees in a range approaching $500 per annum for AEVs and $250 per annum for PHEVs, *on the basis of impacts on sales*.

Proposed flat fee

It is likely a higher level of revenue neutrality and equity would be seen in setting a flat fee based on average MPG of *all* light duty vehicles, not just newly registered one, and to assume an average mileage for both AEVs and PHEVs at this stage (as there is insufficient data as to the average mileage of both types of vehicles in Vermont, and assuming a higher average would unduly penalize a majority of vehicle owners).

The estimated flat fee for AEVs would be $139. For PHEVs, given the estimate that they pay, on average, 68% of the gas tax for all miles, compared to an average gasoline powered vehicle, the flat fee for PHEVs would be $55.

[21] Source: https://cars.usnews.com/cars-trucks/hyundai/ioniq

5. Proposed MBUF and per kWh fee rate structure

Synopsis

Using the criteria set forth in section 3, this section calculates rates for the mileage-based user fee and the per-kWh fee. Given the average distance travelled by light-duty vehicles in Vermont and the average MPG of such vehciles is 22.7 MPG, the average state gas tax paid per mile is $0.013 per mile.

A previsous analysis proposed a rate of $0.034 for the per-kWH fee, revenue replacement rate. The appropriate rate depends upon the amount of revenue sought from such vehicles based on the elasticity of demand versus alternatives. Until that research is accomplished, an inflation-adjsuted fee of $0.04 might be efficient in recovering revenues from nonresident electric vehicle owners traveling on Vermont roads.

Decisions

1. Should Vermont set the mileage-based user fee rate at $0.013 per mile?
2. Should Vermont set the per-kWh fee rate at $0.04 per mile?

Basis for MBUF rate structure

Given the criteria outlined in Section 3 above, an appropriate basis for initially setting MBUF rates for AEVs and PHEVs is to establish rates comparable to what equivalent gasoline powered light-duty vehicles pay in state gas tax in Vermont. For AEVs this is a relatively simple calculation, but for PHEVs there are two possible approaches. One is to charge a MBUF equivalent to the gap between what average PHEVs pay in gas tax when operating using gasoline, and what an average fully gasoline powered light-duty vehicle would pay. Another is to implement the same fee for AEVs and PHEVs, but enable PHEVs to obtain a credit based on actual gas tax paid, by calculating the actual consumption of gasoline using technology on-board the vehicle. This would provide a more accurate, and fairer way to get closer to revenue neutrality between PHEVs, AEVs and gasoline-powered vehicles.

Given the average distance of light-duty vehicles traveled in Vermont per annum is 10,497 miles and the average MPG for such vehicles is 22.7 MPG, the average state gas tax paid per mile is **$0.013 per mile.[22]** This should apply as a rate to AEVs and PHEVs, with the latter receiving a

[22] Note, this does not factor in any costs of collection, although this is estimated to be in the range of 10-25% extra, depending on scale, concept of operations and means of procurement.

credit for any gas tax paid. If such a credit is not proposed, then the rate for PHEVs should be based on the difference between the average gas tax paid by PHEVs per mile and that for the average light-duty vehicle. Further data is needed for this to be calculated more accurately, but based on information sourced from 2016, it is assumed the rate is an average of 37.9 MPG, which would result in a PHEV per mile rate of $0.005 per mile.[23] However, this rate is *not* recommended, as more up to date data, based on actual PHEV usage in Vermont may indicate that this fuel efficiency figure is too low (which would make the proposed rate too low).

Basis for per kWh fee structure

The basis for a per kWh fee for public charging facilities only is fundamentally different from that for a flat fee or a MBUF. Given that the majority of charging (perhaps as high as 80%) of AEVs and PHEVs is done at home, such a fee is not able to recover a similar proportionate level of revenue from such vehicles *on average* as it could only recover revenue for a subset of vehicle charging.[24] Such a fee applying only to non-Vermont registered AEVs and PHEVs would also be unable to recover a proportionate level of revenue, although it is unclear what proportion of gas refueling and AEV/PHEV charging in Vermont is undertaken by out of state registered vehicles.

Previous analysis proposed a rate of $0.034 per kWh as a revenue replacement rate, inflation adjustment of that rate would update it to $0.04 per kWh. If such a fee were to apply to *all* AEVs and PHEVs, then it would only be applying to around 20% of charging (as a proportion of total charging), but if only applied to non-Vermont AEVs/PHEVs, then it should capture most of such users.

It is assumed that the purpose of any per kWh fee for public charging facilities is *not* to seek to recover an equivalent proportion of revenue from AEVs and PHEVs as is done for gasoline-powered vehicles, but rather to recover revenue for the gas taxes avoid by non-resident AEV and PHEV drivers. On that basis, the appropriate fee depends on the amount of revenue sought from such vehicles, and be based on elasticity of demand of using public charging stations vs. alternatives. To establish this would require surveys of AEV and PHEV owners to indicate the proportions willing to pay different prices for public charging stations vs. charging out of state or using gasoline (for PHEVs). A fee of $0.04 per kWh might be efficient in recovering revenues from out of state AEVs/PHEVs, as it might be broadly equivalent to the gas tax, as long as the costs of collection (and fraud mitigation) were kept sufficiently low.

[23] Source: https://afdc.energy.gov/vehicles/electric_emissions_sources.html
[24] Source: https://www.driveelectricvt.com/charging-stations/public-charging-map

6. Equity impacts

Background

The scope of this equity impact is to consider the distributional impacts of a flat fee, MBUF or a per kWh fee on AEV and PHEV owners in Vermont. It does not consider the wider equity impacts of not placing fees on such vehicle owners, leaving the cost burden of maintaining Vermont's roads predominantly with those that drive gasoline (and diesel) fueled motor vehicles and from those without a motor vehicle, through other sources of taxation. However, it is important to be aware of this broader strategic context. At present, AEV owners do not directly contribute to the costs of maintaining and developing Vermont's roads as much as other vehicle owners (though they pay registration fees and vehicle sales taxes). PHEV owners contribute, but to a much lower degree (ranging from around 40 to 70% depending on relative usage of gasoline vs. electricity).

Although Vermont has the average youngest vehicle fleet in the US at 9.9 years[25], the average age of AEVs is around 3.9 years (US wide)[26], indicating that the ownership of AEVs is likely to be concentrated among those able to afford newer vehicles. This is likely to be similar for PHEVs.

It is important to remember that if either a flat fee or MBUF are applied to AEVs and PHEVs, at a rate proportionate to that of the gas tax for gasoline powered light duty vehicles, that the impact will be similar to that of the state gas tax. Ideally, any new fee on AEVs and PHEVs will have impacts no greater than the gas tax has on gasoline powered vehicle ownership and usage.

There are several dimensions to this:

1. Owners of vehicles with fuel efficiency below that of the state average already pay more to use the roads than those with high fuel efficiency. AEVs and PHEVs are significantly more fuel efficient than the average gasoline powered vehicle, so long term equity impacts are more likely to arise with owners of older gasoline-powered vehicles.

2. In general, owners of gasoline-powered vehicles pay more as they use roads more, because the gas tax is not a flat fee nor is it capped. Any flat fee will charge more people who drive less than the average mileage per annum, but will charge fewer who drive the most miles. Compared to the gas tax and MBUF, a flat fee set at a rate the average driver pays in gas tax or MBUF inherently benefits those who drive the most. This can only be mitigated by setting the fee at a higher level, but this would penalize those that drive fewer miles on average. This is an inherent limitation of the concept of a flat fee.

3. Gas tax is paid in the state where gasoline is purchased, but flat fees are only levied in the state where a vehicle is registered. MBUF could be levied on all eligible vehicles in a

[25] Source: https://www.vnews.com/Have-an-old-car-You-re-not-alone-Vehicle-age-hits-record-26610994

[26] Source: https://www.businesswire.com/news/home/20210614005149/en/Average-Age-of-Cars-and-Light-Trucks-in-the-U.S.-Rises-to-12.1-years-Accelerated-by-COVID-19-According-to-IHS-Markit

state, whether they are registered there or not (this is exactly how such fees are applied to heavy-duty vehicles in four states and multiple countries in Europe). Per kWh fees for public charging stations could be applied to any or all users of such facilities, regardless of state of registration.

Urban vs. rural impacts

A key concern over MBUF in particular is that fees that tax vehicle usage by distance, compared to fuel consumption (or a flat fee) unduly penalize rural residents compared to urban residents. The perception is that because vehicle owners in rural areas are further away from cities and towns, that they may drive longer distances on average compared to vehicle owners in urban centers.

There are two key dimensions to this issue in Vermont:

- What proportion of AEV and PHEV vehicles are owned by residents in predominantly rural counties?
- What is the profile of usage of light-duty vehicles in rural communities compared to urban communities?

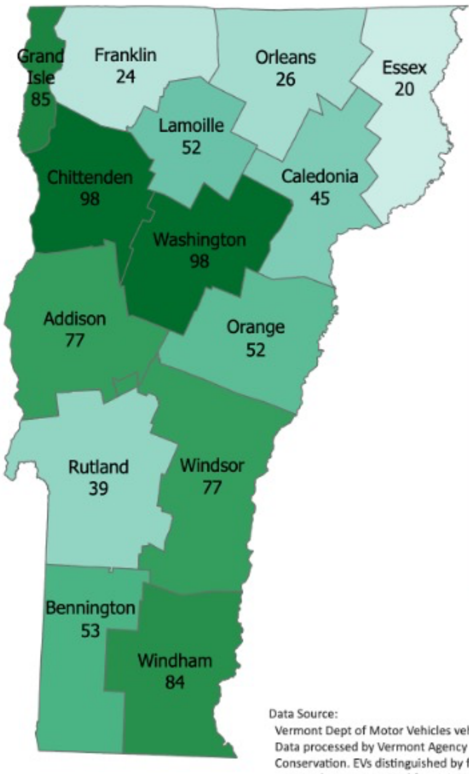
Ownership of AEVs and PHEVs

Analysis of data around the ownership of AEVs and PHEVs indicates that it is largely concentrated in the more urban counties in Vermont. Vermont is one of the lowest density and rural oriented states, and although definitions of rural and urban vary considerably, the statewide population density averages at just under 68 people per square mile. For the purposes of this study, three counties with average population density of over 70 people per square mile were considered to be "urban", which includes Franklin (78.3), Washington (85), and Chittenden (305).[27] Nearly 55% of all AEVs registered in Vermont are located in those four counties, where 44% of the population lives. For PHEVs, around 53% of PHEVs registered in Vermont are located in those four counties. Such vehicles are moderately more likely to be owned in urban areas than rural ones. Similarly the five lowest density counties (Essex (9.2), Grand Isle (36.8), Orleans (38.8), Orange (42) and Addison (48.2)) have only 13% of AEVs and 11% of PHEVs, with 16% of the state's population in those counties. This moderate tendency for AEV and PHEV purchasers to be in more urban areas reflects trends in other states, but is not sufficient in itself to demonstrate that the impact of fees on AEVs and PHEVs would have low impacts in rural areas.

[27] Source: https://www.ers.usda.gov/webdocs/DataFiles/53180/25600_VT.pdf?v=0

Vermont Electric Vehicles Per 10,000 People

By County as of January 2021



County	Population	All Electric	Plug-in Hybrid	Total EVs	EVs per 10,000 People
Addison	36,937	147	136	283	76.6
Bennington	35,446	80	109	189	53.3
Caledonia	29,773	33	101	134	45.0
Chittenden	164,323	816	800	1,616	98.3
Essex	6,133	3	9	12	19.6
Franklin	49,647	47	70	117	23.6
Grand Isle	7,179	26	35	61	85.0
Lamoille	25,364	55	76	131	51.6
Orange	28,835	83	66	149	51.7
Orleans	26,901	26	44	70	26.0
Rutland	57,879	101	127	228	39.4
Washington	58,363	272	301	573	98.2
Windham	42,064	140	215	355	84.4
Windsor	54,977	224	197	421	76.6

This material is based upon work supported by the Vermont Public Service Department, Vermont Agency of Natural Resources, Vermont Agency of Transportation, and the Vermont Department of Buildings and General Services.

Data Source:
Vermont Dept of Motor Vehicles vehicle registration database as of 12/28/2020.
Data processed by Vermont Agency of Natural Resources Dept of Environmental Conservation. EVs distinguished by fuel type, model and/or VIN.
County data summarized from zip code geography. Population from 2020 US Census Estimates.
Does not include 21 vehicles with registration ZIP codes outside of Vermont.

www.driveelectricvt.com

Figure 1 Map of AEV and PHEV ownership in Vermont[28]

Comparison of urban and rural road usage

Concerns over the possible impacts of fees on rural drivers compared to urban drivers have been raised in previous programs. The issue was addressed in Oregon in the Final Report for the OReGO program.[29] A study conducted by Oregon State University indicated that rural drivers drive further per trip than urban drivers, but take fewer trips and on balance rural drivers drive only slightly more than urban drivers. The conclusion was:

Results show that statewide, on average, households will pay about the same—five cents more on average per day—under a road usage charge system than under the current fuel tax system. Interestingly, the increase for rural regions is less than the statewide average, while those in more urban areas will pay slightly more...than the statewide average. This is because rural

[28] Source; Drive Electric Vermont https://www.driveelectricvt.com/Media/Default/docs/maps/vt_ev_registration_trends.pdf
[29] See https://www.oregon.gov/odot/Programs/RUF/IP-Road%20Usage%20Evaluation%20Book%20WEB_4-26.pdf

drivers on average drive lower fuel efficiency vehicles than those in urban areas, who are more likely to drive more fuel efficient vehicles.[30]

For Vermont, where urban drivers are more likely to own AEVs and PHEVs, a similar hypothesis appears credible. The RUC West consortium of states undertook an additional study which indicated that the daily vehicle mileage traveled in 9 states (when comparing urban and rural drivers), varied by state. This variation suggested the impact of a MBUF on rural drivers was unlikely to be significantly different from urban drivers.[31] FHWA statistics indicate that around 71% of miles driven in Vermont are on roads in rural areas, compared to 30% for the national average, but this does not necessarily indicate that rural vehicles are driven on average travel significantly further miles per annum than equivalent urban vehicles.[32] This is because Vermont has around 65% of residents living in rural areas, which would indicate that it is appropriate for such a higher proportion of miles to be driven in rural areas.[33] These statistics include heavy-duty vehicles, which are already noted as traveling, on average, much further miles per annum than light duty vehicles. FHWA statistics likewise indicate that combination and single-unit trucks travel, nationally, further miles on rural roads than urban roads, comprising 14.2% of all mileage driven on rural roads but only 7% of all mileage on urban roads.[34]

Conclusion on urban vs. rural impacts

There is insufficient data on the urban/rural distribution of AEVs and PHEVs in Vermont, but given available data on vehicle ownership distributions, proportions of distance traveled and evidence from other states, it appears likely that any new fees on AEVs and PHEVs would have a greater impact on urban areas in Vermont. Flat fees have equivalent impacts in urban and rural areas as they are unaffected by usage patterns. Given the very high proportion of AEV and PHEV charging undertaken at home, fees on public charging stations are unlikely to have significant impacts on AEV and PHEV owners in urban or rural areas, although a subset of such owners that undertake longer trips to locations further from home are likely to pay more (except if they are excluded as Vermont residents from the impact of a per-kWh fee upon the transfer of electricity at public charging stations), additional research might be undertaken to understand the demographics of public charging station users. For a MBUF, it is likely that there would be no disproportionate impact on rural owners of AEVs and PHEVs than urban owners, particularly in comparison to the current impact of the gas tax on gasoline-powered light-duty vehicle owners.

Impacts by income category

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30 P.55, Oregon's Road Usage Charge, The OReGO Program, Final Report, ODOT, February 2017 (https://www.oregon.gov/odot/Programs/RUF/IP-Road%20Usage%20Evaluation%20Book%20WEB_4-26.pdf)
Sourced from https://www.oregon.gov/ODOT/Programs/ResearchDocuments/SPR774_RoadUsageCharge_Final.pdf

31 See Table 17 in https://www.ebp-us.com/sites/default/files/project/uploads/FINAL-REPORT---Financial-Impacts-of-RUC-on-Urban-and-Rural-Households_Corrected.pdf

32 Source: https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm2.cfm

33 Source: Pg. 12 https://ljfo.vermont.gov/assets/Subjects/Commission-Resources/05a742b874/Population-Changes-and-Vermont-State-Revenue-FULL-REPORT.pdf

34 Source: https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm

The two key influences as to the impacts of a flat fee, MBUF or per kWh fee on lower income households are:

- Profile of owners of AEVs and PHEVs;
- Profile of usage of such owners.

VTrans surveys indicate that the main barrier to ownership of AEVs and PHEVs as high upfront costs, particularly given that the supply of such vehicles is relatively new, there is not yet an extensive market in used AEVs and PHEVs.

Data on the Zip codes with the highest proportions of AEVs and PHEVs in Vermont[35] correlates with the highest income Zip codes in the state.[36] Nationwide 79% of AEV purchases are undertaken in households with incomes of over $50k per annum (57% of over $100k), and 80% of PHEV purchases, with 87% purchased by buyers who identified as white.[37] 78% of AEV or PHEV owners live in households with two or more vehicles. More significantly, there is no apparent change in the income profile of AEV/PHEV buyers since 2012.[38]

The conclusion is that the likely equity impacts of fees on AEVs and PHEVs is neutral to positive if it is taking into account the use of net revenues to contribute towards the costs of the state's transportation system. At present, owners of such vehicles pay significantly less than owners of gas vehicles, and there is some evidence that the average mileage of such vehicles is not necessarily less than that of gasoline-powered vehicles. This suggests that flat fees based on average VMT or MBUF based on average MPG would have no net-negative impacts on more vulnerable households in Vermont.

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[35] Source: Pg. 3 https://www.driveelectricvt.com/Media/Default/docs/maps/vt_ev_registration_trends.pdf
[36] Source: https://www.zipdatamaps.com/economics/income/agi/state/wealthiest-zipcodes-in-vermont
[37] Source: Pg. 10 https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf
[38] Source: Pg. 17 https://www.fuelsinstitute.org/Research/Reports/EV-Consumer-Behavior/EV-Consumer-Behavior-Report.pdf

7. Keeping fees current

Synopsis

This section discusses the need for policies keeping fees current given the tendency for erosion of revenues because of inflation and changes in the composition and numbers of vehicles within the vehicle fleet. The primary objectives for ensuring fees remain current are (1) revenue sustainability, and (2) equitable allocation of costs among road users.

The best practices for keeping fees current include two broad approaches:

- Automatic adjustment based on inflation and factors such as average fleet fuel-efficiency; and
- Determining cost responsibility by vehicle type by revenue modeling based on projected spending, inflation, vehicle mles traveled and fleet changes.

Decisions

1. Should the Vermont RUC program automatically adjust the RUC rates for inflation and other similar factors?
2. Should the Vermont RUC program adjust RUC rates based on cost responsibility by vehicle type?

A major issue influencing the sustainability of existing sources of revenue from motor vehicles is ensuring fees keep pace with the needs of the state. There are three key impacts on the sustainability of gas tax revenues:

- Inflation, eroding the value of revenues
- Changes in the vehicle fleet and miles traveled
- Demands on spending of revenues.

Inflation is not just consumer price inflation, but inflation of the costs of spending on road maintenance and construction, and other aspects of the transportation system. Even if it is assumed that state transportation spending is kept constant, in real terms, that means that fees must increase to reflect any inflation in that spending. This is technically the easiest element to address, but politically has its own challenges. Any automatic inflation adjustment also risks reducing the pressure on contractors to manage costs if they assume they can increase based on whatever inflation measure is used.

Changes in the vehicle fleet include changes in the numbers of vehicles and the composition of the fleet. The former tends to reflect economic activity and consumer preferences, whereas the latter includes changes in technology, such as acquisition of AEVs to replace gasoline powered vehicles. Such changes can be forecast based on recent trends and trends in other jurisdictions, and may require policy to periodically adjust so that fees reflect an element of revenue neutrality.

Demands on spending may change for political or external reasons. Political reasons such as commitments for new capital spending, or external reasons such as natural disaster or urgent maintenance for safety reasons. Expenditure can be forecast several years in advance, and fee setting should reflect the level of spending supported politically and administratively, while remaining able to adjust to policy changes or other circumstances.

Objectives

The primary objectives of ensuring fees remain current are:

- Revenue sustainability.
- Equitable allocation of costs (ensuring that the proportions of transportation costs paid by different types of road users are efficient and equitable

Revenue sustainability means the total *quantum* of revenue collected remains equivalent over time and supports sustaining spending on transportation infrastructure at a steady level. This is challenged by both inflation and changes in motor vehicle fleet composition and use. This may also be challenged by the behavioral impacts of the rate structure. For example, a per-kWh fee for public charging stations may have revenue eroded if it encourages use of other energy sources for AEVs and PHEVs.

Equitable allocation of costs means the distribution of *how much different road users pay* both the means, and the distribution of fees amongst different types of vehicle and levels of road use. At present, gasoline tax effectively collects more revenue from vehicles that consume the most gasoline, which is a function of how many miles are driven, the efficiency of the engine and the behavior of the driver. Gasoline tax applies at the same rate for all vehicles powered by that fuel. A flat fee can only vary by how it is set and applied to different types of vehicles. A mileage-based fee can also vary by the rate applied to different types of vehicles, but also may include location, time of day and ultimately depends on how much distance is traveled by the relevant vehicle. A per-kWh based fee may also be applied to different types of vehicles, and could vary by location of charging, but ultimately depends on the consumption of electricity by the vehicle from charging points subject to the fee.

Over time, the proportions of revenue collected from different types of vehicles and road users will vary based on changes to the fleet and changes in road usage patterns. Whether such a variation is sustainable and equitable depends on the extent and type of variation, and how this might be reflected in spending on transportation. For example, if changes in the fleet result in higher proportions of commuter trips being undertaken by AEVs and PHEVs, which are subject to a lower fee than other vehicles and spending on transportation shifts towards providing more road capacity for peak time travel, this is arguably inequitable as the type of vehicles benefiting the most from the new spending are contributing less towards it.

Best practice elsewhere

Although many jurisdictions effectively keep fees current through ad-hoc political agreement, better practices are seen in those jurisdictions that take a more methodical approach to keeping fees current. There are two broad approaches:

- Automatic adjustment based on inflation and similar factors;
- Revenue modeling based on projected spending, inflation, VMT and fleet changes.

These are not mutually exclusive. Fifteen states apply some form of regular inflation adjustment, with most using the Consumer Price Index, but some (such as Alaska and Colorado) applying the National Highway Construction Cost Index.[39] The latter is likely to be more effective in ensuring revenues remain sustainable for a given level of construction/maintenance activity. Inflation adjustment can be done annually or less regularly, but the larger the period between rate changes, the higher such changes are likely to be and the greater political pressure to veto or stop inflation adjustment to mitigate the impact on road users.

Beyond inflation adjustment, other factors may be used to inform rate changes. Georgia and Indiana review rates for gas tax based on average fuel efficiency of the fleet. This is effectively redundant for flat fees or mileage-based fees, for which revenue is not affected by fuel efficiency or engine choice. However, a per-kWh fee may have its revenue potential eroded by improvements in electric engine efficiency, so there may be merits in including such a calculation in periodic rate reviews.

More sophisticated jurisdictions, such as Oregon, model the total revenue sought for transportation spending, classified across different categories of spending. Such a revenue model considers inflation, changes in the registered vehicle fleet composition, forecast VMT by vehicle type and applies a cost responsibility approach to estimating how much different types of vehicles should be charged for using the roads. This is particularly pertinent with the state's Weight-Mileage Tax which applies to heavy-duty vehicles, as the rate schedule needs to reflect the greater wear and tear imposed by heavier weights.

Recommended approach

A cost responsibility approach combined with revenue modeling enables a state to forecast future road maintenance spending, apply economic factors to attribute proportions of that

[39] Source: https://www.ncsl.org/research/transportation/variable-rate-gas-taxes.aspx

maintenance cost based on weight and based on general VMT, so that rates can be adjusted based on a forward-looking approach.

A full revenue modeling approach need not be done annually, but can be revised less regularly, to reflect any changes in priorities and forecast spending in future years. Ideally such modeling should consider spending from at least three but could forecast up to ten years of expenditure on transportation. Longer periods allow for spending on larger projects or activities with long lead times to be included in forecasts and accounted for in developing rates over that period. It also allows for elected officials to be informed as to what projected revenues will be to enable budgets to be considered, and to test various scenarios around changes in rate levels and their impacts on revenues.

This approach should be combined with reviews of the gas tax to get a holistic view of revenue sources and proposed spending, so that revenue levels can be checked against forecasts and policy revised. If more than one fee option is selected (for example, MBUF with a per-kWh fee) this can be modeled with different scenarios, to test how best to raise revenue against rate setting criteria.